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SMITHSONIAN MISCELLANEOUS COLLECTIONS.

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DIRECTIONS

FOR

COLLECTING AND PRESERVING

INSECTS.

PREPARED FOR THE USE OF

THE SMITHSONIAN INSTITUTION,

BY

A. S. PACKARD, Jr., M.D.

WASHINGTON:
SMITHSONIAN INSTITUTION.
SEPTEMBER, 1873.

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ADVERTISEMENT.

In the Smithsonian Report for 1858, a paper was published on the method of collecting and preserving insects, prepared by Baron Ostensacken, of the Russian Legation, with contributions by other eminent entomologists, which has rendered valuable service in the way of awakening an interest in Entomology and in facilitating the collecting of specimens. It was, however, not stereotyped, and as the methods of gathering and preserving insects have been much improved since its date, it has been thought advisable to request Dr. Packard, as a leading authority, to furnish a new treatise on the same subject. In compliance with this request he has prepared the following pages, derived mainly from the "Guide to the Study of Insects,"* though with some additions and corrections, corresponding with the present state of our knowledge.

JOSEPH HENRY,

Secretary Smithsonian Institution.

Smithsonian Institution,
Washington, September, 1873.

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DIRECTIONS FOR COLLECTING AND PRESERVING INSECTS.

GENERAL CONSIDERATIONS.

INSECTS differ sexually in that the female often appears to have one abdominal ring less (one ring disappearing during the semi-pupa state, when the ovipositor is formed), and in being larger, fuller, and duller colored than the males, while the latter often differ in sculpture and ornamentation. In collecting, whenever the two sexes are found united they should be pinned upon the same pin, the male being placed highest. When we take one sex alone we may feel sure that the other is somewhere in the vicinity; perhaps while one is flying about so as to be easily captured the other is hidden under some leaf, or resting on the trunk of some tree near by, which must be examined and every bush in the vicinity vigorously beaten by the net. Many species rare in most places have a *metropolis* where they occur in great abundance. During seasons when his favorites are especially abundant, the collector should lay up a store against years of scarcity.

At no time of the year need the entomologist rest from his labors. In the winter, under the bark of trees and in moss, he can find many species, or detect their eggs on trees, etc., which he can mark for observation in the spring when they hatch out.

He need not relax his endeavors day or night. Mothing is night employment. Skunks and toads entomologize at night. Early in the morning, at sunrise, when the dew is still on the leaves, insects are sluggish and easily taken with the hand; so at dusk, when many species are found flying; and in the night, the collector will be rewarded with many rarities, some species flying then that hide themselves by day, while many caterpillars leave their retreats to come out and feed, when the lantern can be used with success in searching for them.

Wollaston (Entomologist's Annual, 1865) states that sandy districts, especially towards the coast, are at all times preferable to clayey ones, but the intermediate soils, such as the loamy soil of swamps and marshes, are more productive. Near the sea, insects occur most abundantly beneath pebbles and other objects in grassy spots, or else at the roots of plants. In many places, especially in alpine tracts, as we have found on the summit of Mt. Washington and in Labrador, one has to lie down and look carefully among the short herbage and in the moss for Coleoptera.

The most advantageous places for collecting are gardens and farms, the borders of woods and the banks of streams and ponds. The deep, dense forests, and open, treeless tracts are less prolific in insect life. In winter and early spring the moss on the trunks of trees, when carefully shaken over a newspaper or white cloth, reveals many beetles and Hymenoptera. In the late summer and autumn, toadstools and various fungi and rotten fruits attract many insects, and in early spring when the sap is running we have taken rare insects from the stumps of freshly cut hard-wood trees. Wollaston says, "Dead animals, partially dried bones, as well as the skins of moles and other vermin which are ordinarily hung up in fields, are magnificent traps for Coleoptera; and if any of these be placed around orchards and inclosures near at home, and be examined every morning, various species of *Nitidulæ*, *Silphidæ*, and other insects of similar habits, are certain to be enticed and captured.

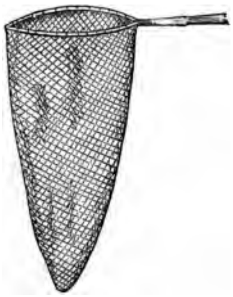
"Planks and chippings of wood may be likewise employed as successful agents in alluring a vast number of species which might otherwise escape our notice, and if these be laid down in grassy places, and carefully inverted every now and then with as little violence as possible, many insects will be found adhering beneath them, especially after dewy nights and in showery weather. Nor must we omit to urge the importance of examining the under sides of stones in the vicinity of ants' nests, in which position, during the spring and summer months, many of the rarest of our native Coleoptera may be occasionally procured." Excrementitious matter always contains many interesting forms in various stages of growth.

The trunks of fallen and decaying trees offer a rich harvest for many wood-boring larvæ, especially the Longicorn beetles; and weevils can be found in the spring, in all stages. Numerous carnivorous Coleopterous and Dipterous larvæ dwell within them, and other larvæ which eat the dust made by the borers. The inside of pithy plants like the elder, raspberry, blackberry, and syringa, is inhabited by many of the wild bees, *Osmia*, *Ceratina*, and the wood-wasps, *Crabro*, *Stigma*, etc., the habits of which, with those of their Chalcid and Ichneumon parasites, offer endless amusement and material for study.

Ponds and streams shelter a vast throng of insects, and should be diligently dredged with the water-net, and stones and pebbles should be overturned for aquatic beetles, Hemiptera and Dipterous larvæ.

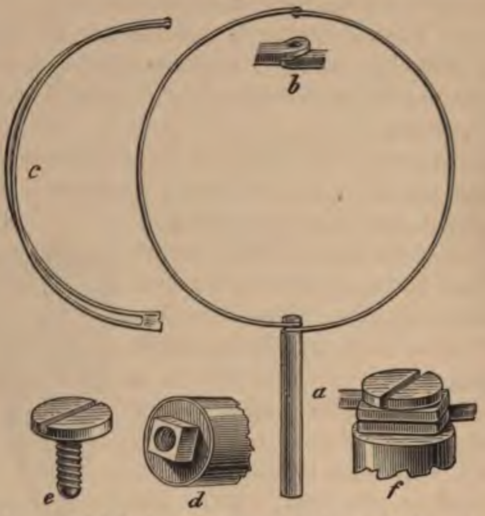
The various sorts of galls should be collected in spring and autumn and placed in vials or boxes, where their inhabitants may be reared, and the rafters of out-houses, stone-walls, etc., should be carefully searched for the nests of mud-wasps.

Fig. 1.



Collecting Apparatus. First in importance is the *net*. (Fig. 1.) This is made by attaching a ring of brass wire to a handle made to slide on a pole six feet long. The net may be a foot in diameter, and the bag itself made of thin gauze or mosquito-netting (the finer, lighter, and more durable the better), and should be about twenty inches deep. It should be sewed to a narrow border of cloth placed around the wire. A light net like this can be rapidly turned upon the insect with one hand. The insect is captured by a dexterous twist which also throws the bottom over the mouth of the net. "The frame of the net which I use is illustrated herewith (Fig. 2), and will be found strong and serviceable and conveniently portable. It is constructed as follows: Take two pieces of stout brass wire, each about 20 inches long; bend them half-circularly and join at one end by a folding hinge having a check on one side (*b*). The other ends are bent and beaten into two square sockets (*f*) which fit to a nut sunk and soldered into one end of a brass tube (*d*). When so fitted, they are secured by a large-headed screw (*e*) threaded to fit into the nut-socket, and with a groove wide enough to receive the back of a common pocket knife blade. The wire hoop is easily detached and folded, as at *c*, for convenient carriage; and the handle may be made of any desired length by cutting a stick and fitting it into the hollow tube *a*, which should be about six inches long. It is well to have two separate hoops—one of lighter wire furnished with silk gauze or some other light material for catching flying insects; and one which is stouter and furnished with a net of stronger material for sweeping non-flying specimens.

Fig. 2.

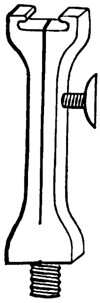


"Another still more simple, but less convenient, frame is thus described by my friend F. G. Sanborn, of Boston, Mass.:

"'Make a loop of strong iron or brass wire, of about 3-16ths of an inch in thickness, so that the diameter of the loop or circle will not exceed twelve inches, leaving an inch to an inch and a half of wire at each end bent at nearly right angles. Bind the two extremities of the wire together with smaller wire and tin them by applying a drop of muriate of zinc, then holding it in the fire or over a gas flame until nearly red hot, when a few grains of block tin or soft solder placed upon them will flow evenly over the whole surface and join them firmly together. Take a Maynard rifle cartridge tube, or other brass tube of similar dimensions; if the former, file off the closed end or perforate it for the admission of the wire, and having tinned it in the same manner on the inside, push a tight fitting cork half-way through and pour into it melted tin or soft solder, and insert the wires; if carefully done, you will have a firmly constructed and very durable foundation for a collecting net. The cork being extracted will leave a convenient socket for inserting a stick or walking cane to serve as a handle.'

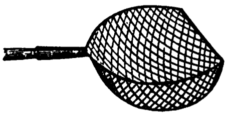
"My friend, J. A. Lintner, of Albany, New York, makes very good use, in his ordinary promenades, of a telescopic fish-rod, with a head (Fig. 3) screwed on to one end, in which to fasten an elastic brass coil on which the net is drawn, but which when not in use sets snugly inside his silk hat." (C. V. Riley, Fifth Annual Report Ins. Mo., 1873.)

Fig. 3.



The insect should be temporarily held between the thumb and forefinger of the hand at liberty, and then pinned through the thorax while in the net. The pin can be drawn through the meshes upon opening the net. The *beating-net* should be made much stouter, with a shallower cloth bag and attached to a shorter stick. It is used for beating trees, bushes, and herbage for beetles and Hemiptera and various larvæ. Its thorough use we would recommend in the low vegetation on mountains and in meadows. The *water-net* may be either round or of the shape indicated in Fig. 4. The ring should be made of brass, and the shallow net of grasscloth or coarse millinet. It is used for collecting aquatic insects.

Fig. 4.



Various sorts of *forceps* are indispensable for handling insects. Small delicate narrow-bladed forceps, with fine sharp points, such as are used by jewellers, and made either of steel or brass, are excellent for handling minute specimens. For larger ones long, curved forceps (Fig. 5, after Riley) are very convenient. For pinning insects into boxes the forceps should be stout, the blades blunt and curved at the end so that the insects can be pinned without slanting the forceps much. The ends need to be broad and finely indented by lines so as to hold the pin firmly. With a little practice the forceps soon take the place of the fingers. They will have to be made to order by a neat workman or surgical instrument maker. Fig. 6, after Riley, illustrates another form. Some persons use the ordinary form of pliers with curved handles, but they should be long and slender. A spring set in to separate the handles when not grasped by the hand is a great convenience.

Fig. 5.

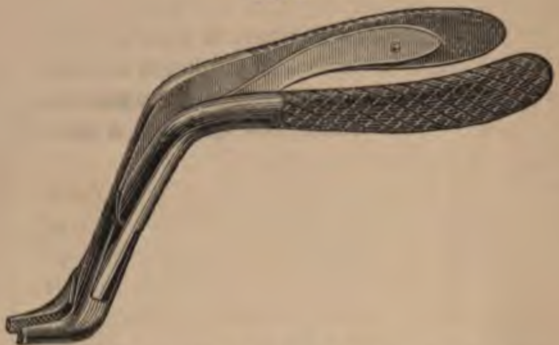
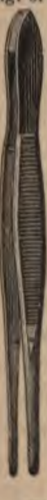


Fig. 6.



Various pill-boxes, vials and bottles must always be taken, some containing alcohol or whiskey. Many collectors use a wide-mouthed bottle, containing a sponge saturated with ether, chloroform, or benzine, or bruised laurel leaves, the latter being pounded with a hammer and then cut with scissors into small pieces, which give out exhalations of prussic acid strong enough to kill most small insects.

Besides these the collector needs a small box lined with corn-pith, or cork, and small enough to slip into the coat-pocket; or a larger box carried by a strap. Most moths and small flies can be pinned alive without being pinched (which injures their shape and rubs off the scales and hairs), and then killed by pouring a little benzine into the bottom of the box.

Killing Insects for the Cabinet. Care in killing affects very sensibly the looks of the cabinet. If hastily killed and distorted by being pinched, with the scales rubbed off and otherwise mangled, the value of such a specimen is diminished either for study or the neat appearance of the collection.

Besides the vapor of ether, chloroform and benzine, the fumes of sulphur readily kill insects. Large specimens may be killed by inserting a pin dipped in a strong solution of oxalic acid. An excellent collecting bottle is made by putting into a wide-mouthed bottle two or three small pieces of cyanide of potassium, which may be covered with cotton, about half-filling the bottle (Figure 7, after Riley). The cotton may be covered with paper lightly attached to the glass and pierced with pin-holes; this keeps the insects from being lost in the bottles. For Diptera, Loew recommends moistening the bottom of the collecting box with creosote. This is excellent for small flies and moths, as the mouth of the bottle can be placed over the insect while at rest; the insect flies up into the bottle and is immediately suffocated. A bottle well prepared will, according to Laboulbène, last several months, even a year, and is vastly superior to the old means of using ether or chloroform. He states, "the inconvenience of taking small insects from a net is well known, as the most valuable ones usually escape; but by placing the end of the net, filled with insects, in a wide-mouthed bottle, and putting in the cork for a few minutes, they will be suffocated." A chloroform bottle with a brush securely inserted in the cork (Fig. 8, after Riley) is often convenient.

Fig. 8.

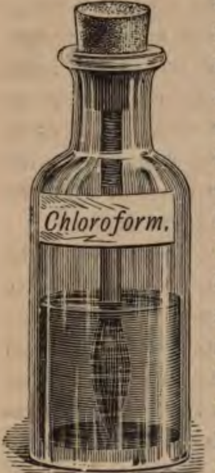
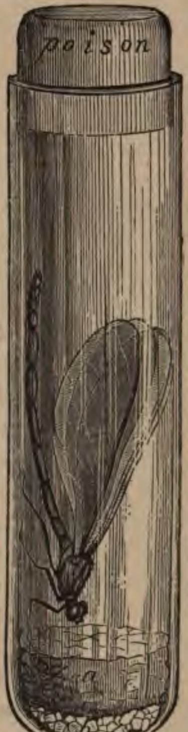


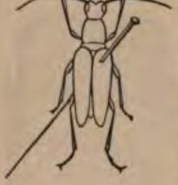
Fig. 7.



Pinning Insects. The pin should be inserted through the thorax of most insects. The Coleoptera, however, should be pinned through the right wing-cover (Fig. 9); many Hemiptera are best pinned through the scutellum (Fig. 10). The specimens should all be pinned at an equal height, so that about one-fourth of the pin should project above the insect.

The best pins are those made in Germany. For very minute insects very small pins are made. They may be used to impale minute insects upon, and then stuck through a bit of cork, or pith, through which a large, long pin may be thrust. Then the specimen is kept out of the reach of devouring insects. Still smaller pins are made by cutting off bits of very fine silvered wire at the right length, which may be thrust by the forceps into a piece of pith, after the insects have been impaled upon them.

Fig. 9.

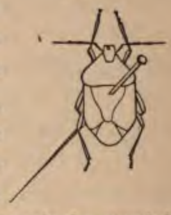


Small insects, especially beetles, may be mounted on cards or pieces of mica through which the pin may be thrust. The French use small oblong bits of mica, with the posterior half covered with green paper on which the number may be placed. The insects may be gummed on the clear part, the two sexes together. The under side can be seen through the thin mica.

Others prefer triangular pieces of card, across the end of which the insect may be gummed, so that nearly the whole under side is visible.

Mr. Wollaston advocates gumming small Coleoptera upon cards. Instead of cutting the pieces of card first, he gums them promiscuously upon a sheet of card-board. "Having gummed thickly a space on your card-board equal to, at least, the entire specimen when expanded, place the beetle upon it, drag out the limbs with a pin, and, leaving it to dry, go on with the next one that presents itself. As the card has to be cut afterwards *around* your insect (so as to suit it), there is no advantage in gumming it precisely *straight upon your frame*,—though it is true that a certain amount of care in this respect lessens your after labor of cutting off very materially. When your frame has been filled, and you are desirous of separating the species, cut out the insects with finely pointed scissors."

Fig. 10.



For mending broken insects, *i. e.*, gumming on legs and antennæ which have fallen off, inspissated ox-gall, softened with a little water, is the best gum.

For gumming insects upon cards, Mr. Wollaston recommends a gum "composed of three parts of tragacanth to one of Arabic, both in powder; to be mixed in water containing a grain of corrosive sublimate, without which it will not keep, until of a consistency just thick enough to run. As this gum is of an extremely absorbent nature, nearly a fortnight is required before it can be properly made. The best plan is to keep adding a little water, and stirring it every few days, until it is of the proper consistency. It is advisable to dissolve the grain of corrosive sublimate in the water which is poured *first* upon the gum."

Preservative Fluids. The best for common use is alcohol, diluted with a little water; or whiskey, as alcohol of full strength is too strong for caterpillars, etc., since it shrivels them up. The spirits should afterwards be changed for alcohol of full strength for permanent preservation. Glycerine is excellent for preserving the colors of caterpillars, though the internal parts decay somewhat, and the specimen is apt to fall to pieces on being roughly handled.

Laboulbène recommends, for the preservation of insects in a fresh state, plunging them in a preservative fluid consisting of alcohol with an excess of arsenic acid in fragments, or the common white arsenic of commerce. A pint and a half of alcohol will take about fourteen grains (troy) of arsenic. The living insect, put into this preparation, absorbs about $\frac{3}{1000}$ of its own weight. When soaked in this liquor and dried, it will be safe from the ravages of moths, *Anthrenus* or *Dermestes*. This liquid will not change the colors of blue, green or red beetles if dried after soaking from twelve to twenty-four hours. Hemiptera and Orthoptera can be treated in the same way.

A stay of a month in this arseniated alcohol mineralizes the insect, so that it appears very hard, and, after drying, becomes glazed with a white deposit which can, however, be washed off with alcohol. In this state the specimens become too hard for dissection and study, but will do for cabinet specimens designed for permanent exhibition.

Another preparation recommended by Laboulbène is alcohol containing a variable quantity of corrosive sublimate, but the latter has to be weighed, as the alcohol evaporates easily, the liquor becoming stronger as it gets older. The strongest solution is one part of corrosive sublimate to one hundred of alcohol; the weakest and best is one-tenth of a part of corrosive sublimate to one hundred parts of alcohol. Insects need not remain in this solution more than two hours before drying. Both of these preparations are very poisonous and should be handled with care. The last-named solution preserves specimens from mould, which will attack pinned insects during damp summers.

A very strong brine will preserve insects until a better liquor can be procured. Professor A. E. Verrill recommends two simple and cheap solutions for preserving, among other specimens, the larvæ of insects "with their natural color and form remarkably perfect." The first consists of two and a half pounds of common salt and four ounces of nitre dissolved in a gallon of water and filtered. Specimens should be prepared for permanent preservation in this solution by being previously immersed in a solution consisting of a quart of the first solution and two ounces of arseniate of potash and a gallon of water.

The nests, cocoons, and chrysalides of insects may be preserved from injury from other insects by being soaked in the arseniated alcohol, or dipped into benzine, or a solution of carbolic acid or creosote.

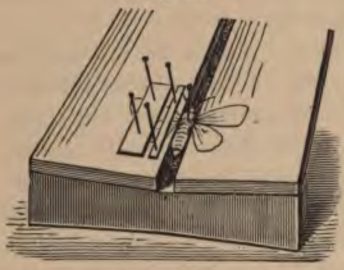
Dr. J. L. Leconte has published in the "American Naturalist," iii, p. 307, some new directions for the preservation of insects which will apply to beetles as well as other insects. "Surgical art has given to us an instrument by which a poisonous liquid can be rapidly and most effectively applied to the entire surface of large numbers of specimens as they stand in the cabinet boxes, without the trouble of moving them. I refer to the 'Atomizer.'

"Opinions may vary as to the nature of the liquid poison to be used, but after several trials I have found the following formula to be quite satisfactory; it produces no efflorescence, even on the most highly polished species, while the odor is quite strong, and persistent enough to destroy any larvæ or eggs that may be already in the box:— saturated alcoholic solution of arsenious acid, eight fluid ounces; strychnine, twelve grains; crystallized carbolic acid, one drachm; mineral naptha (or heavy benzine) and strong alcohol, enough to make one quart. I have not stated the quantity of naptha, since there are some varieties of light petroleum in commerce which dissolve in alcohol only to a slight extent. These should not be used. The heavier oils which mix indefinitely with alcohol are the proper ones, and for the two pints of mixture ten to twelve fluid ounces of the naptha will be sufficient. Care should be taken to test the naptha on a piece of paper. If it leaves a greasy stain which does not disappear after a few hours it is not suitable for this purpose.

"The best form of atomizer is the long, plated, reversible tube; it should be worked with a gum elastic pipe, having two bulbs to secure uniformity in the current. The atomizing glass tubes and the bottle, which usually accompany the apparatus, are unnecessary; a common narrow necked two ounce bottle will serve perfectly to hold the fluid."

Preparing Insects for the Cabinet. Dried insects may be moistened by laying them for twelve or twenty-four hours in a box containing a layer of wet sand, covered with one thickness of soft paper. Their wings can then be easily spread. *Setting-boards* for spreading the wings of insects may be made by sawing deep grooves in a thick board, and placing a strip of pith or cork at the bottom. The groove may be deep enough to allow a quarter of the length of the pin to project above the insect. The setting-board usually consists of thin parallel strips of board, leaving a groove between them wide enough to receive the body of the insect, at the bottom of which a strip of cork or pith should be glued. The ends of the strips should be nailed on to a stouter strip of wood, raising the surface of the setting-board an inch and a half, so that the pins can stick through without touching. Several setting-boards can be made to form shelves in a frame covered with wire gauze, so that the specimens may be preserved from dust and destructive insects, while the air may at the same time have constant access to them. The surface of the board should incline a little towards the groove for the reception of the insect, as the wings often gather a little moisture, relax and fall down after the insect is dried. "For the proper setting of insects with broad and flattened wings, such as butterflies and moths, a spreading board or stretcher is necessary. One that is simple and answers every purpose is shown at figure 11. It may be made of two pieces of thin white-wood or pine board, fastened together by braces, especially at the ends, and left wide enough apart to admit the bodies of the insects to be spread: strips of cork or pith, in which to fasten the pins, may then be tacked or glued below so as to cover the intervening space. The braces must be deep enough to prevent the pins from touching anything on which the stretcher may be laid; and, by attaching a ring or loop to one of them, the stretcher may be hung against a wall, out of the way. For ordinary-sized specimens I use boards 2 feet long, 3 inches wide and ⅛ inch thick, with three braces (one in the middle and one at each end) 1½ inches deep at the ends, but narrowing from each end to 1⅙ inches at the middle. This slight rising from the middle is to counteract the tendency of the wings, however well dried, to drop a little after the insect is placed in the cabinet. The wings are held in position by means of strips of paper (Fig. 11) until dry." (Riley.)

Fig. 11.



Moths of medium size should remain two or three days on the setting-board, while the larger thick-bodied sphinges and *Bombycidæ* require a week to dry. The wings can be arranged by means of a needle stuck into a handle of wood. They should be set horizontally, and the front margin of the fore wings drawn a little forward of a line perpendicular to the body, so as to free the inner margin of the hind wings from the body, that their form may be distinctly seen. When thus arranged, they can be confined by fine threads drawn over the wings, by pieces of card pinned to the board as indicated in figure 11, or, as we prefer, by square pieces of glass laid upon them.

After the insects have been thoroughly dried they should not be placed in the cabinet until after having been in quarantine to see that no eggs of Dermestes or Anthrenus, etc., have been deposited on them.

For preserving dried insects in the cabinet Laboulbène recommends placing a rare insect (if a beetle or any other hard insect) in water for an hour until the tissues are softened. If soiled, an insect can be cleansed under water with a fine hair-pencil, then submit it to a bath of arseniated alcohol with corrosive sublimate. If the insect becomes prune-colored, it should be washed in pure alcohol several times. This method will do for the rarest insects; the more common ones can be softened on wet sand, and then the immersion in the arseniated alcohol suffices. After an immersion of from a quarter of an hour to an hour, according to the size of the insect, the pin is not affected by the corrosive sublimate, but it is better to unpin the insect previous to immersion, and then pin it when almost dry.

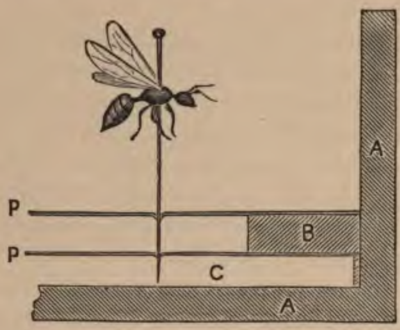
For cleaning insects ether or benzine is excellent, applied with a hair-pencil; though care should be taken in using these substances, which are very inflammable.

After the specimens are placed in the cabinet, they should be farther protected from destructive insects by placing in the drawers or boxes pieces of camphor wrapped in paper perforated by pin-holes, or bottles containing sponges saturated with benzine. The collection should be carefully examined every month; the presence of insects can be detected by the dust beneath them. Where a collection is much infested with destructive insects, benzine should be poured into the bottom of the box or drawer, when the fumes and contact of the benzine with their bodies will kill them. The specimens themselves should not be soaked in the benzine if possible, as it renders them brittle.

Insect-cabinet. For permanent exhibition, a cabinet of shallow drawers, protected by doors, is most useful. A drawer may be eighteen by twenty inches square, and two inches deep in the clear, and provided with a tight glass cover. For constant use, boxes made of thin, well-seasoned wood, with tight fitting covers, are indispensable. For Coleoptera, Dr. Leconte recommends that they be twelve by nine inches (inside measurement). For the larger Lepidoptera a little larger box is preferable. Others prefer boxes made in the form of books, which may be put away like books on the shelves of the cabinet, though the cover of the box is apt to be in the way.

The boxes and drawers should be lined with cork cut into thin slips for soles; such slips come from the cork-cutter about twelve by four inches square, and an eighth of an inch thick. A less expensive substitute is paper stretched upon a frame. Prof. E. S. Morse has given in the "American Naturalist" (vol. i, p. 156) a plan which is very neat and useful for lining boxes in a large museum, and which are designed to be placed in horizontal show-cases (Fig. 12). "A box is made of the required depth, and a light frame is fitted to its interior. Upon the upper and under surfaces of this frame, a sheet of white paper (drawing or log-paper answers the purpose) is securely glued. The paper, having been previously damped, in drying contracts and tightens like a drum-head. The frame is then secured about one-fourth of an inch from the bottom of the box, and the pin is forced down through the thicknesses of paper, and if the bottom of the box be of soft pine, the point of the pin may be slightly forced into it. It is thus firmly held at two or three different points, and all lateral movements are prevented. Other advantages are secured by this arrangement besides firmness; when the box needs cleaning or fumigation, the entire collection may be removed by taking out the frame; or camphor, tobacco, or other material can be placed on the bottom of the box, and concealed from sight. The annexed figure represents a transverse section of a portion of the side and bottom of the box with the frame. A, A, box; B, frame; P, P, upper and under sheets of paper; C, space between lower sheets of paper and bottom of box."

Fig. 12.



Other substitutes are the pith of various plants, especially of corn; and palm wood, and "inodorous felt" are used, being cut to fit the bottom of the box.

Leconte recommends that "for the purpose of distinguishing specimens from different regions, little disks of variously colored paper be used; they are easily made by a small punch, and should be kept in wooden pill-boxes ready for use; at the same time a key to the colors, showing the regions embraced by each, should be made on the fly-leaf of the catalogue of the collection." He also strongly recommends that the "specimens should all be pinned at the same height, since the ease of recognizing species allied in characters is greatly increased by having them on the same level."

He also states that "it is better, even when numbers with reference to a catalogue are employed, that the name of each species should be written on a label attached to the first specimen. Thus the eye is familiarized with the association of the species and its name, memory is aided, and greater power given of identifying species when the cabinet is not at hand." For indicating the sexes the astronomical sign ♂ (Mars) is used for the male, and ♀ (Venus) for the female, and ☿ for the worker.

Transportation of Insects. While travelling, all hard-bodied insects, comprising many Hymenoptera, the Coleoptera, Hemiptera, and many Neuroptera should be thrown, with their larvæ, etc., into bottles and vials filled with strong alcohol. When the bottle is filled new liquor should be poured in, and the old may be saved for collecting purposes; in this way the specimens will not soften and can be preserved indefinitely, and the colors do not, in most cases, change. Leconte states that "if the bottles are in danger of being broken, the specimens, after remaining for a day or two in alcohol, may be taken out, partially dried by exposure to the air, but not so as to be brittle, and these packed in layers in small boxes between soft paper; the boxes should then be carefully closed with gum-paper or paste, so as to exclude all enemies."

Lepidoptera and dragon-flies and other soft-bodied insects may be well preserved by placing them in square pieces of paper folded into a triangular form with the edges overlapping. Put up thus, multitudes can be packed away in tin boxes, and will bear transportation to any distance. In tropical climates, chests lined with tin should be made to contain the insect-boxes, which can thus be preserved against the ravages of white ants, etc.

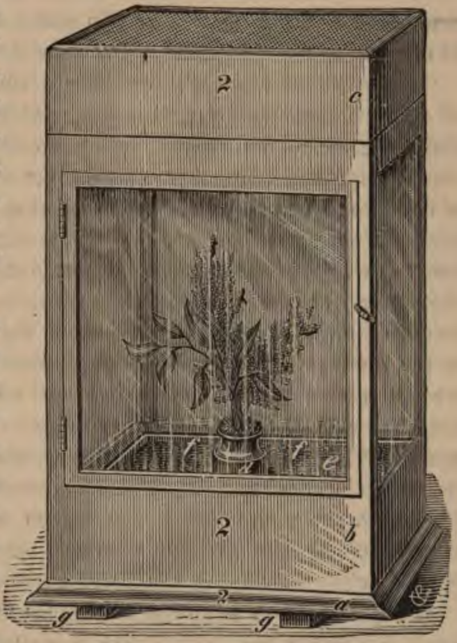
In sending live larvæ by mail, they should be inclosed in little tin boxes, and in sending dry specimens, the box should be light and strong, and directions given at the post-office to stamp the box lightly. In sending boxes by express they should be carefully packed in a larger box, having an interspace of two inches, which can be filled in tightly with hay or crumpled bits of paper. Beetles can be wrapped in pieces of soft paper. Labels for alcoholic specimens should consist of parchment with the locality, date of capture, and name of collector written in ink. A temporary label of firm paper with the locality, etc., written with a pencil, will last for several years.

Preservation of Larvæ. Alcoholic specimens of insects, in all stages of growth, are very useful. Few collections contain alcoholic specimens of the adult insect. This is a mistake. Many of the most important characters are effaced during the drying process, and for purposes of general study alcoholic specimens, even of bees, Lepidoptera, Diptera, and dragonflies are very necessary.

Larvæ, generally, may be well preserved in vials or bottles of alcohol. They should first be put into whiskey, and then into alcohol. If placed in the latter first, they shrivel and become distorted. Mr. E. Burgess preserves caterpillars with the colors unchanged, by immersing them in boiling water thirty or forty seconds, and then placing them in equal parts of alcohol and water. It is well to collect larvæ and pupæ indiscriminately; even if we do not know their adult forms we can approximate to them, and in some cases tell very exactly what they must be.

Rearing Larvæ. More attention has been paid to rearing caterpillars than the young of any other suborder of insects, and the following remarks apply more particularly to them, but very much the same method may be pursued in rearing the larvæ of beetles, flies, and Hymenoptera. Subterranean larvæ have to be kept in moist earth, aquatic larvæ must be reared in aquaria, and carnivorous larvæ must be supplied with flesh. The larvæ of butterflies are rare; those of moths occur more frequently, while their imagos may be scarce. In some years many larvæ, which are usually rare, occur in abundance, and should then be reared in numbers. In hunting for caterpillars bushes should be shaken and beaten over newspapers or sheets, or an umbrella; herbage should be swept, and trees examined carefully for leaf-rollers and miners. The best specimens of moths and butterflies are obtained by rearing them from the egg, or from the larva or pupa. In confinement the food should be kept fresh, and the box well ventilated. Tumblers covered with gauze, pasteboard boxes pierced with holes and fitted with glass in the covers, or large glass jars, are very convenient to use as cages. The bottom of such vessels may be covered with moist sand, in which the food-plant of the larva may be stuck and kept fresh for several days. Larger and more airy boxes, a foot square, with the sides of gauze, and fitted with a door, through which a bottle of water may be introduced, serve well. The following extract from Riley's "Fifth Annual Report on the Injurious Insects of Missouri" illustrates his style of vivarium:—

Fig. 13.



"For larger insects I use a breeding cage or vivarium of my own devising, and which answers the purpose admirably. It is represented in figure 13, and comprises three distinct parts: 1st, the bottom board (*a*), consisting of a square piece of inch-thick walnut with a rectangular zinc pan (*ff*), 4 inches deep, fastened to it, above, and with two cross pieces (*gg*) below, to prevent cracking or warping, facilitate lifting, and allow the air to pass underneath the cage. 2d, a box (*b*), with three glass sides and a glass door in front, to fit over the zinc pan. 3d, a cap (*c*), which fits closely on to the box, and has a top of fine wire gauze. To the centre of the zinc pan is soldered a zinc tube (*d*) just large enough to contain an ordinary quinine bottle. The zinc pan is filled with clean sifted earth or sand (*c*), and the quinine bottle is for the reception of the food-plant. The cage admits of abundant light and air, and also of the easy removal of the excrement and frass which fall to the ground; while the insects in transforming enter the ground or attach themselves to the sides or the cap, according to their habits. The most convenient dimensions I find to be 12 inches square and 18 inches high: the cap and the door fit closely by means of rabbets, and the former has a depth of about 4 inches to admit of the largest cocoon being spun in it without touching the box on which it rests. The zinc pan might be made 6 or 8 inches deep, and the lower half filled with sand, so as to keep the whole moist for a greater length of time.

"A dozen such cages will furnish room for the annual breeding of a great number of species, as several having different habits and appearance, and which there is no danger of confounding, may be simultaneously fed in the same cage. I number each of the three parts of each cage to prevent misplacement and to facilitate reference, and aside from the notes made in the note-book, it will aid the memory, and expedite matters, to keep a short open record of the species contained in each cage, by means of slips of paper pasted on to the glass door. As fast as the different specimens complete their transformations and are taken from the cage, the notes may be altered or erased, or the slips wetted and removed entirely. To prevent possible confounding of the different species which enter the ground, it is well, from time to time, to sift the earth, separate the pupæ and place them in what I call imago cages, used for this purpose alone and not for feeding. Here they may be arranged, with reference to their exact whereabouts."

The object is to keep the food-plant fresh, the air cool, the larva out of the sun, and in fact everything in such a state of equilibrium that the larva will not feel the change of circumstances when kept in confinement. Most caterpillars change to pupæ in the autumn; and those which transform in the earth should be covered with earth, kept damp by wet moss, and placed in the cellar until the following summer. The collector in seeking for larvæ should carry a good number of pill-boxes, and especially a close tin box, in which the leaves may be kept fresh for a long time. The different forms and markings of caterpillars should be noted, and they should be drawn carefully together with a leaf of the food-plant, and the drawings and pupa skins, and perfect insect, be numbered to correspond. Descriptions of caterpillars cannot be too carefully made, or too long. The relative size of the head, its ornamentation, the stripes and spots of the body, and the position and number of tubercles, and the hairs, or fascicles of hairs, or spines and spinules, which arise from them, should be noted, besides the general form of the body. The lines along the body are called *dorsal*, if in the middle of the back; *subdorsal*, if upon one side, *lateral*, and *ventral* when on the sides and under surface, or *stigmatal* if including the *stigmata* or breathing pores, which are generally parti-colored. Indeed, the whole biography of an insect should be ascertained by the observer; the points to be noted are:

1. Date when and how the eggs are laid; and number, size, and marking of the eggs.

2. Date of hatching, the appearance, food-plant of larva, and number of days between each moulting; the changes the larva undergoes, which are often remarkable, especially before the last moulting, with drawings illustrative of these; the habits of the larva, whether solitary or gregarious, whether a day or night feeder; the ichneumon parasites, and their mode of attack. Specimens of larvæ in the different moultings should be preserved in alcohol. The appearance of the larvæ when full-fed, the date, number of days before pupating, the formation and description of the cocoon, the duration of larvæ in the cocoon before pupation, their appearance just before changing, their appearance while changing, and alcoholic specimens of larvæ in the act, should all be studied and noted.

3. Date of pupation; description of the pupa or chrysalis; duration of the pupa state, habits, etc.; together with alcoholic specimens, or pinned dry ones. Lepidopterous pupæ should be looked for late in the summer or in the fall and spring, about the roots of trees, and kept moist in mould until the imago appears. Many Coleopterous pupæ may also occur in mould, and if aquatic, under submerged sticks and stones, and those of borers under the bark of decaying trees.

4. Date when the insect escapes from the pupa, and method of escape; duration of life of the imago; and the number of broods in a season.

Classification of Insects. That branch of the Animal Kingdom, known as the *Articulata*, was so called by Cuvier in his work on the animal kingdom, from having the body composed of rings, like short cylinders, which are placed successively one behind the other. In the class of *Worms* these rings or segments are arranged in a continuous row, and their number is indefinite. The organs of locomotion consist of tubercles bearing bristles placed in a row, one on each side of each ring; while on the head-rings there are slender feelers directed forwards and placed around the mouth-opening. In the class of *Crustacea* this continuity of rings is broken, and they for the most part bear hard, jointed appendages; and there is usually a definite number (20), which are gathered into two regions: the head-thorax and abdomen. In the class of *Insects*, the number of rings is still more limited (18), the head, consisting of four rings, is distinctly separated from the thorax, thus forming, with the abdomen or hind-body, three distinct regions.

In the Insects, again, there are three modes of disposing the rings and their appendages:—

1. Where the number of segments is indefinite, and much like each other in form, supporting both thoracic and abdominal legs; as in the order of *Myriopoda.*

2. Where the head and thorax are closely united; and there are four pairs of legs attached to the thorax alone, as in the *Arachnida.*

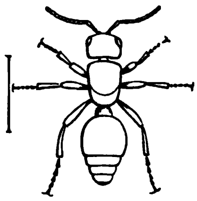
3. Where there are three distinct regions to the body; the head, thorax and abdomen, as in the *Insecta.* Moreover, the true insects have three pairs of legs attached to the thorax; and are, with few exceptions, winged.

The Myriopods grow by the addition of rings, after hatching from the egg; the Arachnids by frequent moultings of the skin; while the winged insects pass through a distinct metamorphosis. The young insect after being hatched from the egg is called the *larva*, from the Latin term meaning a *mask*, since it was the ancient belief that it concealed beneath its skin the form of the perfect insect. When full-fed the pupa-skin rapidly forms beneath the tegument, and the insect in that form escapes through a slit in the back of the larva. The perfect insect is often called the *imago.* The larval state of insects which resemble worms has also an analogous form to the Myriopods; so spiders are analogous to Crustacea, while reminding us of the pupa state of the winged insects.

Moreover, worms and crustacea are, generally speaking, aquatic, breathing by gills, while insects are terrestrial and breathe by pores in the side of the body which communicate with a complex system of air tubes, sometimes enclosed by blood vessels.

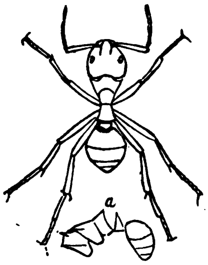
The order of winged insects is subdivided into seven divisions, occupying an intermediate rank between orders and families, and called by naturalists *suborders.** Of these the *Hymenoptera* seem to be highest in the scale, and the *Neuroptera* the lowest.

Fig. 14.



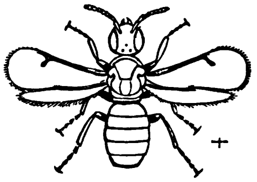
Mutilla.

Fig. 15.



Ant (*Formica*).

Fig. 16.



Chalcid Parasite.

Hymenoptera (Bees, Wasps, etc. Fig. 14, *Mutilla;* Fig. 15, Ant; Fig. 16, a Chalcid parasite) are known by their hard, compact bodies, distinct head and thorax, the small, narrow, irregularly veined wings, and by the possession of a hard ovipositor, often forming a poisonous sting. Their transformations are the most complete of all insects, the larva being most generally a white, footless, helpless grub, partly curved, and rapidly tapering at each end. The pupa has the limbs free, contained in a thin, silken cocoon. The species are all terrestrial.

Lepidoptera (Butterflies and Moths. Fig. 17, *Alypia*, or grape moth and caterpillar) have the mandibles obsolete, the maxillæ greatly prolonged and rolled up between the labial palpi; their bodies are covered with scales; and the broad, regularly veined wings are also covered with dust-like scales. Their transformations are complete. The active larvæ assume a worm-like form with several pairs (1–5) of fleshy false legs besides the thoracic ones; they spin silken cocoons before changing to pupæ (chrysalides, nymphs), with the exception of the butterflies. The limbs of the chrysalides are soldered together, and the abdomen is movable upon the head and thorax.

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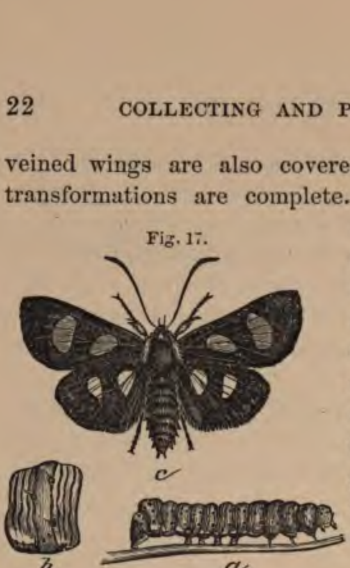
* Or, if preferred, these seven divisions may be regarded as orders, and the three "orders" of insects as subclasses.

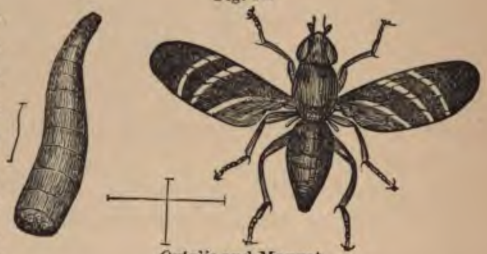
Fig. 17.



Alypia of Grape.

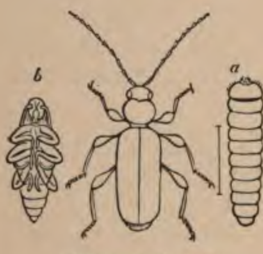
Diptera (Flies. Fig. 18, *Ortalis* fly and larva) have the mouth parts formed into a kind of proboscis; the second pair of wings are undeveloped, being reduced to a pair of pedicelled knobs serving as *balancers* or *poisers*. Their transformations are complete, the larvæ being maggots or elongated worm-like embryos. The pupæ often change within the skin of the larvæ, which serves as a cocoon. The limbs are free. Many of the species are aquatic. Here we first find wingless parasites.

Fig. 18.



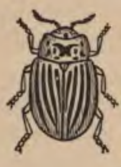
Ortalis and Maggot.

Fig. 19.



Asemum and young.

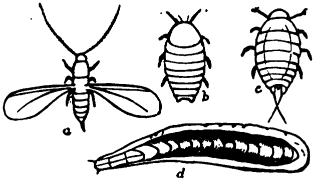
Fig. 20.



Potato Beetle.

Coleoptera (Beetles. Fig. 19, *Asemum* beetle, *a*, larva, *b*, pupa; fig. 20, Potato beetle) are known by their hard bodies, free and well developed mouth parts, and by the first pair of wings being hardened into sheaths (*elytra*) for the protection of the second pair. The larvæ, called *grubs*, often have a terminal prop-leg besides the thoracic or true-jointed legs, and pass by a complete metamorphosis to the imago state. The pupæ are often protected by a cocoon, and have their limbs free. Some of the species are aquatic. One family is parasitic, but is winged.

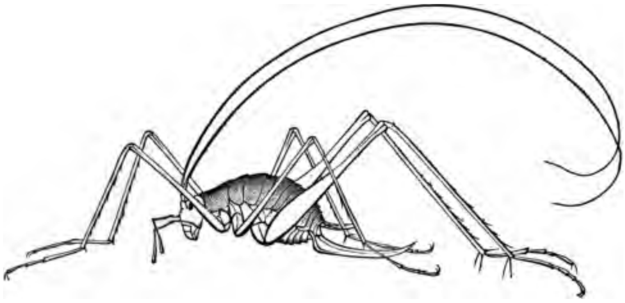
Fig. 21.



Orange scale insect.

Hemiptera (Bugs. Fig. 21, Orange scale insect, *a*, male, *b*, *c*, *d*, larva, female) have the mouth parts formed into a sucking tube. The first pair of wings are often thickened at the base and laid flat upon the abdomen, or are thin, somewhat net-veined, and inclined over the hind body. The transformations are incomplete, as in the Orthoptera. The species are largely aquatic. Some lower groups are true wingless parasites.

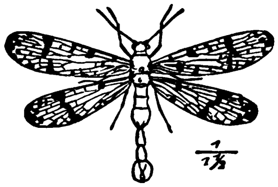
Fig. 22.



Hadenœcus of Mammoth Cave.

Orthoptera (Grasshoppers) have free mouth parts, and the organs of nutrition very highly developed. The first pair of wings are still partly hardened to protect the broad, net-veined hind pair which fold up like a fan upon the abdomen. The transformations are not complete, the larvæ and pupæ resembling closely the imagines, both being active. All the species are terrestrial. (Fig. 22 represents a wingless grasshopper, *Hadenœcus subterraneus*, Scudder, found in Mammoth Cave; other forms of this family occur in caverns.)

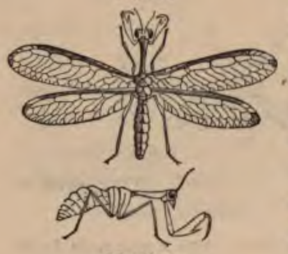
Fig. 23.



Panorpa.

Neuroptera (Fig. 23, Forceps tail, *Panorpa;* Fig. 24, *Mantispa*) have the mouth parts free again, the wings large and net-veined, the hind pair being often larger than the primaries. Their bodies are more elongated than those of other insects. The metamorphosis is incomplete, the larvæ and pupæ closely resemble the imagines, and are both active, and with few exceptions they are all aquatic. The different species present strong analogies to all of the other suborders. The wingless, lower genera present more analogies than other insects to the Myriopods.

Fig. 24.



Mantispa.

The order of *Arachnida* is divided into three suborders:—

Araneina, or spiders, which pass through no metamorphosis.

Pedipalpi, or harvest-men (*Phalangium*) and scorpions, which undergo no metamorphosis, and all agree in having the maxillary palpi enlarged and ending in a forceps, with the abdomen distinctly jointed, and the

Acarina, or mites, the young of which are usually born with but three pairs of feet, and in which the body is oval.

The order of *Myriopoda* is divided into the *Chilopoda*, of which the centipede is a type. In these each ring bears but a single pair of feet, and the body is flattened; while in the second division, the

Chilognatha, the body is cylindrical, and each segment appears to bear two pairs of legs. Of this group the thousand legs (*Julus*) is a type.

SPECIAL DIRECTIONS FOR COLLECTING INSECTS.

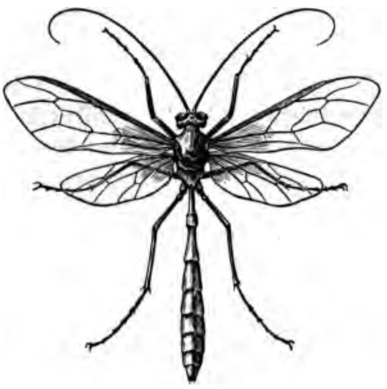
We now proceed to give more special directions for collecting and preserving insects of the different groups.

HYMENOPTERA.

BEES, WASPS, ICHNEUMON FLIES, GALL FLIES AND SAW FLIES.

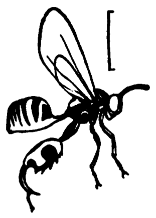
These insects are exceedingly abundant, and especial attention should be paid to collecting the smaller species. They should be pinned through the thorax, high up on the pin, and those that are not hairy collected in alcohol. The hairy species of bees should be pinned while in the net. The minute ichneumon flies should be gummed like small beetles upon cards, or preserved in small pill-boxes. The nests of bees, wasps and ants should be sought for and the entire colony with the young grubs captured and placed in spirits, while especial attention should be given to preserving the different sorts of parasites found in the nest. The nests in various stages of construction should be collected to serve as illustrations of insect architecture.

Fig. 25.



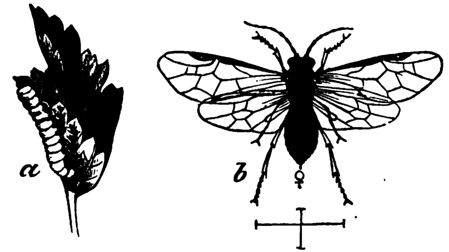
Ichneumon (Ophion.)

Fig. 26.



Chalcis.

Fig. 27.



Saw Fly and Larva.

The gall flies produce by their stings tumors or galls on the leaves or twigs of trees. Specimens of these galls accompanied by the insects that produce them are very desirable. They may be reared by simply placing the mature galls in pill-boxes.

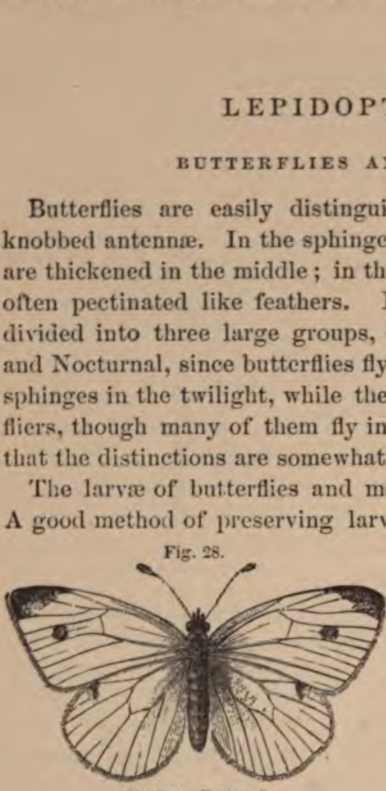
The larva of the saw fly (Fig. 27, *a*) closely resembles a caterpillar having several pairs of abdominal legs.

LEPIDOPTERA.

BUTTERFLIES AND MOTHS.

Butterflies are easily distinguished from moths by their knobbed antennæ. In the sphinges, or hawk-moths, the feelers are thickened in the middle; in the moths they are filiform and often pectinated like feathers. Lepidoptera have also been divided into three large groups, called Diurnal, Crepuscular and Nocturnal, since butterflies fly in the sunshine alone, most sphinges in the twilight, while the moths are generally night-fliers, though many of them fly in the daytime, thus showing that the distinctions are somewhat artificial.

Fig. 28.



Cabbage Butterfly.

The larvæ of butterflies and moths are called caterpillars. A good method of preserving larvæ dry, adopted at Dresden, is to squeeze out the intestines through a hole made near the anal extremity of the larva, then to insert a fine straw, after which it may be put in a glass vase, itself placed in a tin vessel and held over a lamp; the larval skin is blown while suspended over the lamp, by which the skin dries faster. It may be done with a small tube or blow-pipe fixed at the end of a bladder, held under the arm or between the knees, so as to leave the hands at liberty; and the straw which is inserted into the body of the larva may be fastened by a cross-pin stuck through the skin, and thus retained in its proper position throughout the process of blowing. The small larvæ, such as those of the Tineæ, may be put alive into a hot bottle, baked until they swell to the proper extent and dry, when they can be pinned with all their contents inside. (Westwood, Proceedings of the Entomological Society of London, Sept. 7, 1863.)

Dr. Knaggs has, in the "Entomologist's Monthly Magazine," given some directions for managing caterpillars. Very young caterpillars, which will not eat the food provided, and become restless, should be reared in air-tight jam-pots, the tops of which are covered with green glass to darken the interior of the vessel. When small larvæ hide themselves by mining, entering buds and spinning together leaves, they should have as small a quantity of food as possible. In changing larvæ from one plant to a fresh one, a slight jar or puff of breath will dislodge them, and they can be transferred to the jam-pot; or the glass cylinder, covered at one end with muslin, can be turned muslin end downwards for them to crawl upon. The duplicate breeding cage, pot or tube, should be "sweetened" by a free current of fresh dry air and then stocked with fresh food.

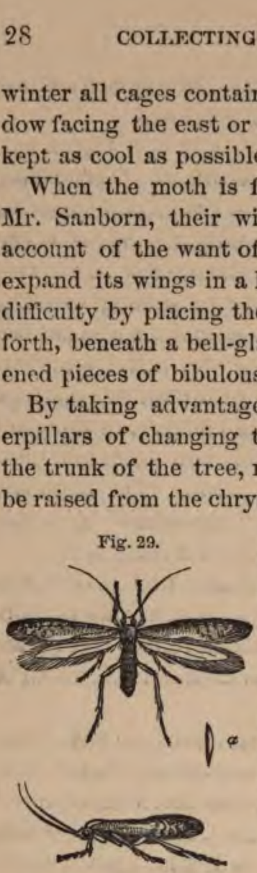
Dr. Knaggs advises that "hiding places," or bits of chips, etc., be provided for such Noctuid larvæ as naturally lie concealed, such as *Orthosia*, *Xanthia*, *Noctua*, etc., "while for *Agrotis* and a few others a considerable depth of fine earth or sand is necessary."

"Larvæ, which in nature hibernate, must either be stimulated by warmth and fresh food to feed up unnaturally fast, or else through the winter must be exposed to out-door temperature." For such larvæ as begin to eat before the trees are leaved out, the leaves of evergreens must be provided, pine leaves, chickweed, grasses and mosses. Hibernating, living larvæ must during the winter be kept dry, otherwise the damp seems to hang about their fur, and causes them to be attacked by a white fungus: while smooth larvæ require the natural dampness of the soil. Mr. Greene describes what he calls his "larvarium, viz.: a very large box, say three feet square and about the same in depth filled partly with mould covered with moss." The edges of the top of this box must be smoothly shaved to suit the lid, which is like the frame of a slate, the slate being knocked out. This is then covered with gauze. In a box of this size small branches may be held in bottles of water, and two or three dozen larvæ safely housed. If placed in a cool room, with plenty of air, they will grow almost as large as if in freedom. Mr. Gibson strongly recommends that during the winter all cages containing larvæ be placed in front of a window facing the east or northeast, so that the inmates may be kept as cool as possible.

When the moth is fairly out of the pupa, as remarked by Mr. Sanborn, their wings often fail to properly expand, on account of the want of moisture, "the insect being unable to expand its wings in a heated, dry room. He has avoided this difficulty by placing the insect just emerged, or about to come forth, beneath a bell-glass, within which he had placed moistened pieces of bibulous paper."

By taking advantage of the habit of many tree-feeding caterpillars of changing to pupæ (pupating) in the soil close to the trunk of the tree, many rare moths can with little trouble be raised from the chrysalides thus found. As the Rev. Joseph Greene (The Insect Hunter's Companion, London, 1870) advises, the dirt around the trunk should be dug up with a trowel, and carefully examined for chrysalides. He adds that "pupæ may be found almost anywhere and everywhere, under moss on large stones and bowlders, in the decayed stumps of old trees, behind the loose bark on palings, between dead leaves, under moss on banks, etc., etc."

Fig. 29.



In studying the interesting family of *Tineidæ* (Fig. 29), Stainton remarks that "the elongated wings, the slender body and the long or very long fringes to the wings, are characters by which the Tineidæ may generally be recognized at once; and the development of the palpi and their variety in form and structure, offer most tangible grounds for separating the greater number of the genera. Indeed, if the student will look at the head of a species to see whether it is hairy or smooth, if he will then notice the palpi, whether the maxillary palpi are developed and to what extent, and whether the labial palpi are slender, ascending or drooping, whether the second joint is densely clothed with scales, or bears a long protruding tuft, and if he will farther notice the form of the hind wings, which are either well rounded or very pointed, or indented towards the tip, he will be perfectly surprised to see how easily he will arrange these insects into genera by their structure."

The larvæ vary excessively in the number of legs, sixteen being the usual number, but in several genera (*Gracilaria*, *Lithocolletis*, etc.), we only find fourteen; in Nepticula, though the legs are but poorly developed, they number eighteen; on the other hand the larvæ of a few of the smaller genera (*Antispila*, *Tinagma*, etc.) are absolutely footless.

For collecting and preserving these minute and delicate moths, which are called by collectors, *Micro-lepidoptera*, especial instructions are necessary. When the moth is taken in the net, it can be blown by the breath into the bottom. "Then by elevating the hand through the ring, or on a level with it, a common cupping glass of about two inches in diameter, or a wine glass carried in the pocket, is placed on top of the left hand over the constricted portion, the grasp relaxed, and the insect permitted to escape through the opening into its interior. The glass is then closed below by the left hand on the outside of the net, and may be transferred to the top of the collecting box, when it can be quieted by chloroform" (Clemens); or the moths may be collected in pill-boxes, and then carried home and opened into a larger box filled with fumes of ether or benzine or cyanide of potassium. In pinching any moths on the thorax, as is sometimes done, the form of that region is invariably distorted, and many of the scales removed. In searching for "Micros" we must look carefully on the *lee side* of trees, fences, hedges and undulations in the ground, for they avoid the wind. Indeed, we can take advantage of this habit of many Micros, and by blowing vigorously on the trunks of trees start the moth off into the net so placed as to intercept it. This method is most productive, C. G. Barrett states, in the "Entomologist's Monthly Magazine," while a steady wind is blowing.

In seeking for the larvæ we must remember that most of them are leaf miners, and their burrows are detected by the waved, brown, withered lines on the surface of leaves, and their "*frass*" or excrement, thrown out at one end. Some are found between united leaves, of which the upper is crumpled. Others construct portable cases which they draw about the trunks of trees, fences, etc. Others burrow in the stems of grass, or in fungi, toadstools and in the pith of currant or raspberry bushes. Most are solitary, a few gregarious. A bush stripped of its leaves and covered with webs, if not done by *Clisiocampa* (the American tent caterpillar), will witness the work of a *Tortrix* or Tineid. Buds of unfolded herbs suffer from their attacks, such as the heads of composite flowers which are drawn together and consumed by the larvæ.

After some practice in rearing larvæ it will be found easier and more profitable to search for the leaf miners, and rear the perfect, fresh and uninjured moths from them. In this way many species never found in the perfect state can be secured.*

In raising "*Micro*" larvæ it is essential that the leaf in which they mine be preserved fresh for a long time. Thus a glass jar, tumbler or jam-pot, the top of which has been ground to receive an air-tight glass cover, and the bottom covered with moist white sand, will keep a leaf fresh for a week, and thus a larva in the summer will have to be fed but two or three times before it changes; and the moth can be seen through the glass without taking off the cover; or a glass cylinder can be placed over a plant inserted in wet sand, having the top covered with gauze. Dr. H. G. Knaggs, in treating of the management of caterpillars in breeding boxes, enumerates the diseases, besides muscardine and cholerine (and we might add pebrine) to which they are subject. Among direct injuries are wounds and bruises, which may be productive of deformities in the future imago; the stings of ichneumon flies, whose eggs laid either upon or in the body may be crushed with finely pointed scissors or pliers; frost bites; and suffocation, chiefly from drowning. If the caterpillar has not been more than ten or twelve hours in the water it may be recovered by being dried on a piece of blotting paper and exposed to the sun. Larvæ may also starve to death, even when food is abundant, from loss of appetite, or improper ventilation, light, etc.; or they may eat too much, become dropsical and die. Caterpillars undoubtedly suffer from a contagious disease analogous to low fever. Many die while moulting, especially the larvæ of butterflies, sphinges and bombycids; others are carried off by diarrhœa, which is generally caused by improper feeding on too juicy or relaxing food, when oak leaves or dry stunted foliage should be given them. To relieve constipation they should be fed with lettuce and other natural purgatives, and lastly, they may be attacked by fungi, especially, besides those previously mentioned, a species of *Oidium*. Such patients should be put in direct sunlight or dry currents of air. (Entomologist's Monthly Magazine, June, 1868.) The pupæ easily dry up; they should be kept moist, in tubes of glass closed at either end, through which the moth can be seen when disclosed.

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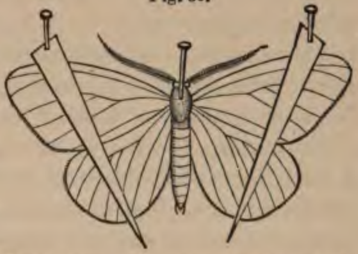
* "In general, it may be said, the mines of the leaf miners are characteristic of the genus to which the larva may belong. A single mine once identified, enables the collector to pronounce on the genus of all the species he may find thereafter. This, added to the ease with which the larvæ are collected, and the little subsequent care required to bring them to maturity, except to keep the leaves in a fresh and healthy state, makes the study of this group, in every respect, pleasant and satisfactory to the entomologist." (Clemens.)

In setting *Micro-lepidoptera:* "If the insect is *very small* I hold it by its legs between the thumb and finger of the left hand, whilst I pierce it with the pin held between the thumb and finger of the right hand; if the insect is not very small I use a rough surface, as a piece of blotting paper, or piece of cloth, for it to lie upon and prevent its slipping about, and then cautiously insert the point of the pin in the middle of the thorax, as nearly as possible in a vertical direction. As soon as the pin is fairly through the insect, remove it to a piece of soft cork, and by pressing it in, push the insect as far up the pin as is required.

Fig. 30.



"For setting the insects I find nothing answers as well as a piece of soft cork, papered with smooth paper, and with grooves cut to admit the bodies. The wings are placed in the required position by the setting needle, and are then retained in their places by a wedge-shaped, thin paper brace (Fig. 30), placed over them till a square brace of smooth card-board is placed over the ends of the wings." (Stainton.) A small square of glass can also be laid on the wings to keep them expanded, and thus serve the same purpose as the paper braces.

Linnæus first set the example of having the specific names of the Tortricids end in *ana* and of the Tineids in *ella*, and at the present day the rule is generally followed by entomologists, who have also given the same terminations to the names of the smaller species of *Pyralides*, such as *Pempelia*, *Crambus* and allied genera.

We may also add Lord Walsingham's directions for collecting *Micro-lepidoptera*, published in the "American Naturalist" (Vol. vi, No. 5.)

"I go out with a coat provided with large pockets inside and out, containing an assortment of pill-boxes, generally of three sizes, glass bottomed pill-boxes preferred, a bag slung over my shoulder, and a net. Unless searching for particular day flying species I prefer the last three hours before dark. As the sun goes down many species move which do not stir at other times. I watch the tops of the grass, the stems of the flowers, the twigs of the trees ; I disturb leaves and low growing plants with a short switch and secure each little moth that moves, taking each out of the net in a separate pill-box, selected according to the size of the insect, as he runs up the net to escape. Transferring the full boxes to the bag I continue the process until moths cease flying or night sets in. Many species can be taken with a lamp after dark.

"Returning to camp I put a few drops of liquid ammonia on a small piece of sponge and place it in a tin canister with such of the boxes as do not contain the smallest species, and put these and the remainder away until morning in a cool place. In the morning I prepare for work by getting out a pair of scissors, a pair of forceps, my drying box containing setting boards, a sheet of white paper and some pins.

"First, I cut two or three narrow pieces of paper from three to six lines wide, or rather wider, according to the size of the largest and smallest specimens I have to set. I then double each of these strips and cut it up into braces by a number of oblique cuts. Now I turn out the contents of the canister and damp the sponge with a few drops of fresh ammonia, refilling with boxes containing live insects. Those which have been taken out will be found to be all dead and in a beautifully relaxed condition for setting. Had the smallest specimens been placed in the canister over night, there would have been some fear of their drying up, owing to the small amount of moisture in their bodies.

"If the weather is very hot there is some danger of killed insects becoming stiff while others are being set, in which case it is better to pin at once into a damp cork box all that have been taken out of the canister, but under ordinary circumstances I prefer to pin them one by one as I set them.

"Taking the lid off a box, and taking the box between the finger and thumb of the right hand, I roll out the insect on the top of the left thumb, supporting it with the top of the fore finger and so manipulating it as to bring the head pointing towards my right hand and the thorax uppermost. Now I take a pin in the right hand and resting the first joint of the middle finger of the right against the projecting point of the middle finger of the left hand to avoid unsteadiness, I pin the insect obliquely through the thickest part of the thorax so that the head of the pin leans very slightly forward over the head of the insect. After passing the pin far enough through to bring about one-fourth of an inch out below,* I pin the insect into the middle of the groove of a setting-board so that the edge of the groove will just support the under sides of the wings close up to the body when they are raised upon it. The board should be chosen of such a size as will permit of the extension of the wings nearly to its outer edge. The position of the pin should still be slanting a little forward. The wings should now be raised into the position in which they are intended to rest, with especial care in doing so not to remove any scales from the surface or cilia of the wings. Each wing should be fastened with a brace long enough to extend across both, the braces being pinned at the thick end, so that the head of the pin slopes away from the point of the brace; this causes the braces to press more firmly down on the wing when fixed. The insect should be braced thus: the two braces next the body should have the points upwards, the two outer ones pointing downwards and slightly inwards towards the body, and covering the main portion of the wings beyond the middle. Antennæ should be carefully laid back above the wings, and braces should lie flat, exercising an even pressure at all points of their surface. The fore wings should slope slightly forwards so that a line drawn from the point of one to the point of the

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*The English mode of pinning low down on a short pin presents so many disadvantages that we would caution collectors to pin high up on a long pin so that three-fourths of its length should project below the body.—*Editor.*

other will just miss the head and palpi. The hind wings should be close up, leaving no intervening space, but just showing the upper angle of the wing evenly on each side. I can give no more precise directions as to how this desirable result may most simply and speedily be attained; no two people set alike. Speed is an object; for I have often had to set twelve dozen insects before breakfast. A simple process is essential, for a man who is always pinning and moving pins, and rearranging wings and legs, is sure to remove a certain number of scales and spoil the appearance of the insect, besides utterly destroying its value. I raise each of the fore wings with a pin and fix the pin against the inner margin so as to keep them in position while I apply the braces. Half the battle is really in the pinning. When an insect is pinned through the exact centre of the thorax with the pin properly sloped forward, the body appears to fall naturally into its position on the setting-board, and the muscles of the wings being left free are easily directed and secured: but if the pin is not put exactly in the middle, it interferes with the play of the wings. Legs must be placed close against the body or they will project and interfere with the set of the wings. Practice, care and a steady hand, will succeed. When all the insects that have been killed are set, the contents of the canister will be found again ready, twenty minutes being amply sufficient to expose to the fumes of ammonia. Very bright green or pale pink insects should be killed by some other process, say chloroform, as ammonia will affect their colors.

"Insects should be left on the setting-boards a full week to dry; then the braces may be carefully removed and they may be transferred to the store box.

"Having given some account of the process each insect goes through, I will say a word as to the apparatus required.

"First as to nets. The simplest net is a strong, circular, iron wire hoop with a bag of book muslin attached, fastened into a light deal or other handle.

"I use a small pocket net about nine inches in diameter made to fold up, with a jointed wire frame and a screw to fit into a brass socket in a short cane handle. To counteract the strain of the net upon so slight a frame the three wire joints are made flat, the two side joints flattened across the strain, the upper one the reverse way; but to prevent this upper joint from coming into play when the net is fixed, the upper part of the screw which holds the frame to the handle is welded square and fits a corresponding square socket in the other end of the wire frame, holding all tight when screwed down. A small green silk or other net can be slipped on or off this frame as required.

"An umbrella net with stout steel rim and canvas edging is useful for sweeping tall grass and herbage, or to beat branches into, by which means many small and beautiful species of retired habits may be obtained.

"I use pill-boxes with glass bottoms, which can be obtained of various sizes. They are convenient in admitting of the examination of each specimen, so rare species can be especially searched for, and damaged ones permitted to escape; but they are expensive and for ordinary purposes card-board boxes answer sufficiently well. It is a good plan at the beginning of a season to strengthen all your boxes by a crossed strap of tape or calico firmly glued at the top and bottom. For a killing box any tin box or canister with a closely fitting lid, capable of containing one hundred pill-boxes will be found to answer.

"Setting-boards can be bought ready made of the smallest sizes. They are made by gluing a strip of thick cork on a thin slip of deal; the cork must be thick enough to enable a groove to be cut into it, deep enough to hold the bodies of the insects to be set, and to leave sufficient depth for the pin to hold firmly without reaching the deal. The cork on each side of the groove should be smoothed off with a gentle curve, so that the wings dry in a good position. The deal backing projects beyond the cork so as to slide into a groove if required, and it is convenient to have a deal cupboard of drying boxes with handle at top and perforated zinc door, having grooves on each side into which the setting boards can be slid. Each board should be papered with thin white paper.

"At the beginning of a season setting-boards may be washed or brushed over with advantage with a weak solution of oxide of zinc; it fills up old pinholes and makes them look clean.

"For *Tortricina* use No. 10 pins; for *Tineina* (small), No. 19; for *Nepticulæ*, No. 20.

"Always set your insects as soon as you kill them, they are then much more easy to set and retain their position better when dry.

"When pill-boxes are filled keep them cool to prevent the insects from fluttering; if glass boxes, keep them also in the dark.

"Many species when first taken will flutter in the boxes and injure themselves; for these it is well when collecting to carry a small phial of chloroform and a zinc collecting box cork-lined, into which you can at once pin your captures; the cork should be damped to keep them fresh. Touching a pill-box with a finger moistened with chloroform will kill the insect inside. Too much chloroform is apt to stiffen the nerves of the wings and interfere with setting.

"By breeding *Microlepidoptera*, many species not otherwise easily obtainable may be added to a collection, and the habits of others in the larva state may be studied with much interest. For this purpose a few wide-mouthed glass bottles should be obtained with corks to fit, so that the small larvæ can be placed in them with fresh food and the food kept fresh by exclusion of air. If mould should appear the cork can be replaced by muslin or net tied over. I would hardly advise a travelling collector to attempt this method although I have adopted it with some success, but in a stationary camp it is most interesting and comparatively easy.

"Cork-lined store boxes are of course required into which to remove the insects when sufficiently dried on the setting boards. These, as well as the pins and setting-boards with drying case to hold them, and the net frames of the folding and umbrella patterns, will be best obtained from some dealer in such things.*

"To pack *Microlepidoptera* for travelling, pin them firmly close together into a cork-lined box, so that each specimen just gently holds down the body of the one above it. This cannot be done with very minute species. Put your box into another larger box and let the outer one be sufficiently large to leave a good clear six inches all around the inner one. Pack this intervening space with hay not crammed too tight; it will act as a spring and reduce the effect of shaking; the whole parcel should be made thoroughly secure against damp."

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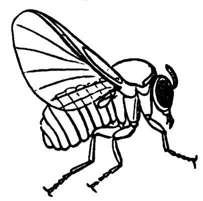
*In London there are several, among whom I would mention T. Cook, New Oxford Street, and Thomas Eedle, Maidstone Place, Hackney Row. The manufacturers of entomological pins, which can, however, be obtained from the above dealers, are Messrs. Eddleston & Williams, Birmingham; Messrs. Kirby & Beard, Canon Street, London. In America, The Naturalists' Agency, Salem. Mass., and C. G. Brewster & Co., Washington St., Boston, keep on hand insect pins, cork, pill-boxes, and most of the other articles required by the collector.

DIPTERA.

FLIES, MOSQUITOES, BOT FLIES, ETC.

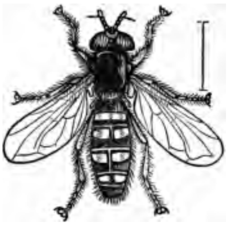
There are about 2,500 species of North American flies described, and it is probable that the number of living North American species amounts to 10,000. In Europe there are also about 10,000 known species, belonging to about 680 genera.

Fig. 31.



Black Fly.

Fig. 32.

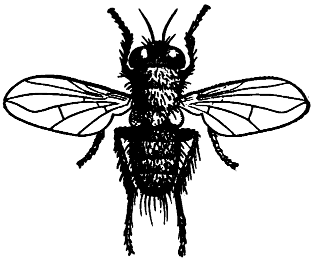


Syrphus Fly.

The flies of this country, compared with the other groups, have been but little studied, though the habits of many are so interesting and the species very numerous. The different parts of the body vary much more than in the Hymenoptera and Lepidoptera, and in such a degree as often to afford comparatively easy characters for discriminating the genera.

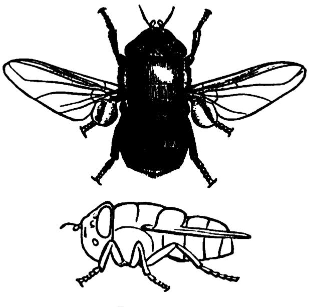
Their habits are very variable. Fresh water aquaria are necessary for the maintenance of aquatic larvæ. If quantities of swamp mud and moss with decaying matter are kept in

Fig. 33.



Tachina Fly.

Fig. 34.

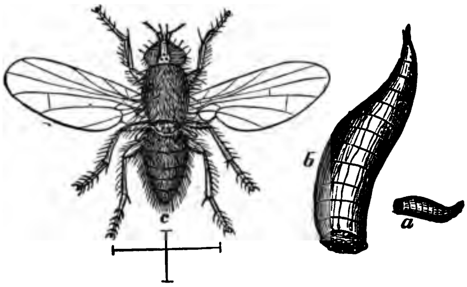


Bot Fly.

boxes and jars, multitudes of small flies will be hatched out. Leaf-mining and seed-inhabiting species can be treated as *Microlepidoptera*, and earth-inhabiting larvæ like ordinary caterpillars. Dung, mould in hollow trees, stems of plants and toadstools, contain numerous larvæ or maggots (Fig. 35) as the young of flies are called, which must be kept in damp boxes.

Flies can be pinned alive, without killing them by pressure, which destroys their form; and numbers may be killed at once by moistening the bottom of the collecting box with creosote, benzine or ether, or putting them into a bottle with a wide mouth, containing cyanide of potassium. Minute species can be pinned with very slender pins, or pieces of fine silver wire, and stuck into pieces of pith, which can be placed high up on a large pin. In pinning long-legged, slender species, it is advisable to run a piece of card or paper up under their bodies upon which their legs may rest, and thus prevent their loss by breakage. Of these insects, as of all others, duplicates in all stages of growth should be preserved in alcohol, while the minute species dry up unless put in spirits.

Fig. 35.



Onion Fly and Maggot.

COLEOPTERA.

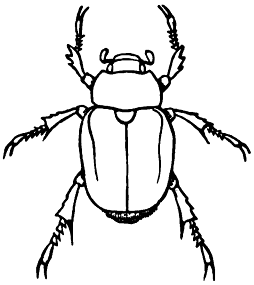
BEETLES.

"Coleopterous insects may be distinguished by the hard shell which incases their bodies; the wings are protected by horny wing covers, but in some the wing covers are small.

It is through the right wing cover (Fig. 9) that they should be pinned for the cabinet. They are found in every variety of situation; on plants, in decomposing animal and vegetable matter, in mushrooms, under bark of trees, under stones, especially in moist and shady situations; many are found creeping on the ground, in deserts and other arid spots in western America; some are attracted by candles at night, while others (in all parts of the country) fly actively on being approached and light again on the ground a few paces off.

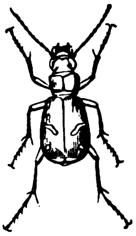
"Many peculiar species, not found in other situations, live under material cast up by the ocean; others are found along the shores of lakes and rivers; many also are found living in the water." (Leconte.)

Fig. 36.



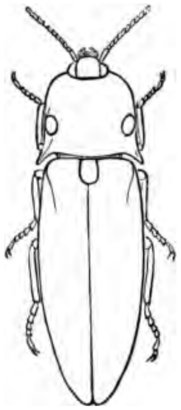
Goldsmith Beetle.

Fig. 37.



Tiger Beetle.

Fig. 38.



Fire Fly.

Mr. Edward Newman says that "moss is a great resort of beetles in the winter; whenever you have the opportunity go into the thickest woods, and pulling up the moss by handfuls cram it into a canvas bag, which you have taken with you for this especial object. Then on a winter's day, when nothing tempts you abroad, shake out your moss, bit by bit, on a white cloth, and you will soon possess yourself of wonders."

"A large number of species are very minute, and are usually found in abundance; these should not be neglected, as to scientific men they possess quite as much interest as the larger species. The specimens should be thrown into strong alcohol;

if this cannot be procured, common whiskey will answer very well, but must, when the specimens are numerous, be replaced by fresh liquor. The smaller specimens should be kept in a separate bottle. When the bottle is full, the liquor should be poured off and replaced by fresh alcohol or whiskey, and closely corked. If there is much danger of breaking in transportation, the specimens, after being well soaked with the alcohol, may be allowed to dry partially, but not so as to become brittle, and then packed in small pasteboard boxes, taking care, by shaking the box well before finally closing it, to pack the specimens so closely that they cannot be broken by moving about; the box may then be closed by pasting a small strip of paper around it, and the locality, date of collection, etc., written on the top." (Leconte.)

We copy from a chapter on collecting Coleoptera, by Edward Newman, in Greene's "Insect Hunter's Companion" (London, 1870), an account of Mr. Crotch's plan of killing and preserving beetles, of especial use while on a long journey.

"The following method has now been in use some time, and hence has been fairly tested. Its advantages are very great, so that I make no apology for introducing it to the notice of your readers. The first idea of the process is due, as far as I know, to M. de Vuille-froi, who used it with me in Spain, some years ago, with great success. The specimens may be collected in two ways, according to the size and the convenience of the collector. The first and best way, for small species, is by putting them into a bottle containing about half an inch of dry pine-sawdust, in which has been previously placed a small piece of cyanide of potassium about as big as a pea: they will then die instantly. Larger species and small species which do not fly readily, may be put into spirits in the ordinary way, but the *Staphylinidæ* and others generally open their wings in this process. The sawdust should be pine-wood and sifted free from chips on the one hand and from dust on the other, so as to be of an uniform size. For storing the species thus collected, a few tin canisters will be found most convenient; a layer of sawdust is placed at the bottom, and then beetles and so on alternately to the top. The sawdust used in the tins should be damped (not *wetted*) with a mixture of spirit and one-twentieth part of carbolic acid, which will effectually prevent mould or mites and will bring the specimens home perfectly fresh and clean. Small species, or specimens from a particular locality, should be wrapped in a piece of rag or tissue-paper, with a little sawdust, and the name of the locality. The specimens collected in spirits should be removed as soon as possible (in a few days at farthest), and transferred to sawdust. When the tins are full, some more spirit and carbolic acid should be poured in and the top soldered down: they will then keep for two years at least. The advantages of this method are manifest, especially in the absence of any danger of breakage or leakage; and it is more than probable that a similar plan might be employed with reptiles, fishes, etc., but for these chloride of zinc suggests itself as the agent most likely to be of service. As the insects do not become rotten by the above process, it is sometimes not so easy to set their legs in the peculiar manner in vogue in this country, but they will have as a set-off the advantage of being thoroughly fit for study. When by any chance spirit cannot be obtained, they will keep perfectly in dry sawdust, if the specimens are dried in the air for a few hours first; all that is necessary afterwards being to relax them in the sawdust instead of removing them from it. Jars or wide-mouthed pickle bottles may of course be used instead of tins, and are more airtight, but liable to break."

"That eminent and most excellent entomologist, Mr. E. W. Janson, endorses Mr. Crotch's recommendation, and adds a few hints on the subject of collecting beetles abroad, as follows:—

"'The sawdust plan, now almost universally adopted by collectors, I can recommend both on account of its simplicity and efficiency. The sawdust should be that of some white or yellow wood without coloring matter—pine is perhaps the best; it should be sifted over fine muslin, and the dust and minute particles rejected. In collecting, wide-mouthed bottles should be used; these should be about one-fourth filled with dry sawdust, adding beneath a piece of cyanide of potassium of the size of a large pea or haricot bean. On reaching home after collecting, the contents of the collecting bottles should be shaken out on a large sheet of paper, and the insects transferred to the stock-bottle or jar, and the cyanide and sawdust returned to the collecting bottles for future use. Any description of wide-mouthed bottles, such as pickle-jars, may be used as stock bottles; they should, however, have tightly-fitting corks or bungs. Before putting the insects collected into the stock bottle, throw into it sawdust a quarter of an inch in thickness, *slightly damped*, not *moistened*, with a mixture made of alcohol (methylated spirit will answer admirably; brandy or strong whiskey, if unsweetened, will suffice, but sweetened gin and rum must be avoided), or, still better, benzine or benzoline, and carbolic or phenic acid. These should be mixed in the proportions of nineteen parts of alcohol or benzine and one part of carbolic acid. On the sawdust damped with this mixture place a layer of insects; over them a second stratum of damped sawdust, then a second layer of insects, and so on alternately until the stock-bottle or jar is filled; take care that it is always kept well-closed. When it is filled it may be packed with any other objects in sawdust, hay, moss, or any other elastic substance, and forwarded to its destination.'"

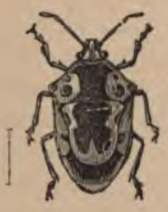
Special attention should be given to the collection of the larvæ of beetles, called grubs. They are found in soil, under the bark of trees, in nuts, etc., and in fresh water pools.

HEMIPTERA.

BUGS, PLANT LICE, BARK LICE, LICE.

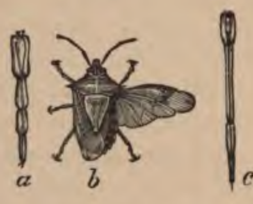
This group of insects has been greatly neglected, as they are not the favorites of entomologists. By sweeping grass and herbage, as for beetles, in the latter part of summer, large numbers occur which can only be obtained in this way. Hi-

Fig. 39.



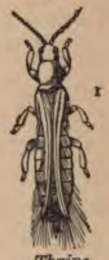
Stiretrus.

Fig. 40.



Arma.

Fig. 41.

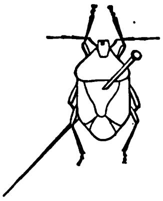


Thrips.

bernating species are found under leaves in hard-wood forests. The large carnivorous kinds are sometimes found on bushes with caterpillars transfixed on their jaws. Aquatic species should be taken out by the water-net by thrusting it suddenly under surface swimming species, or by pushing it among submerged grass or weeds where the smaller forms may be lurking; several kinds occur under submerged logs, sticks, etc.

The soft-bodied species of *Aphis* or plant lice should be preserved in alcohol, glycerine or Canada balsam. They should be carefully watched for their parasites, and can be easily kept in slender glass vials through which they can be watched.

Fig. 42.



All the bugs should be pinned through the distinct triangular scutellum situated in the middle at the base of the wings (Fig. 42). The small hard species of leaf hoppers should be pinned through the right wing cover. Birds and various quadrupeds should be carefully examined for lice which may be preserved in alcohol.

ORTHOPTERA.

GRASSHOPPERS.

Orthoptera can be easily preserved in strong alcohol, and may afterwards be taken out and pinned and set at leisure. If preserved dry they can be killed with cyanide of potassium, or ether, without losing their colors, as they would do after remaining long in alcohol. They should be pinned through a little triangular spot between the bases of the elytra, or fore wings, when the wings can be spread to advantage. They are also often pinned through the right elytron, as in Coleoptera. In pinning these insects for transportation care should be taken to put in additional pins crossing each other on each side of the abdomen, and in like manner to steady the hind legs, which are very apt to fall off if too much jarred.

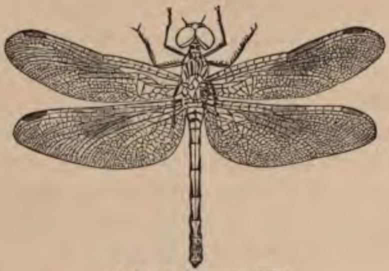
NEUROPTERA.

DRAGON FLIES, MAY FLIES, CADDIS FLIES, ETC.

These insects, the young of which frequently live in fresh water ponds and streams, should be pinned through the centre of the thorax, the smaller and more delicate kinds immediately on capture should be pinned in the collecting box.

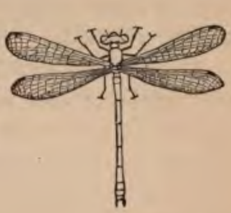
The Psoci (Fig. 45, *Cœcilius*) live on leaves and the bark of trees, and are more or less social. They closely resemble the *Aphis*.

Fig. 43.



Libellula (Dragon Fly).

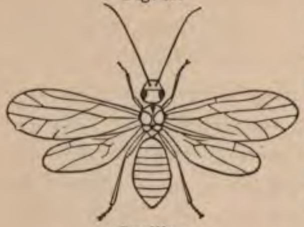
Fig. 44.



Agrion.

As regards the preservation of the dragon flies, Mr. Uhler states that "the large, brilliant green dragon flies (*Cordulina*), as well as the yellow, brown-striped *Gomphina*, having the eyes wide apart, will furnish new species in almost all parts of the country. In order to preserve specimens in the neatest manner it is well to slip them immediately, when caught, into paper bags of suitable size; first taking care to lay back the wings so that they will be applied together, to prevent mutilation. These paper bags may be placed loosely in a box carried for the purpose. They can thus be taken out at leisure, killed by applying a camel's hair pencil, dipped in sulphuric ether, chloroform, or benzine, to the under side of the body, and then have the wings spread by placing them upon the setting boards. In most species the colors change after death,

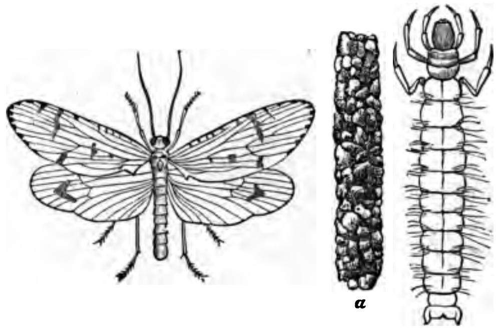
Fig. 45.



Cœcilius.

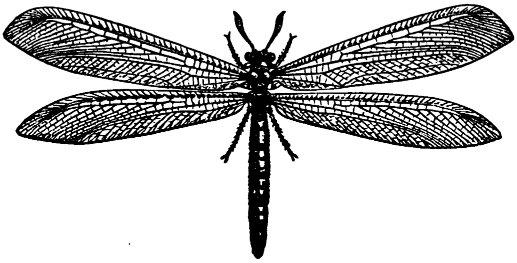
hence it is important to make short descriptions of the colors before killing the specimens." The smaller, more slender and delicate Neuroptera should be pinned directly in the collecting box. Many species are caught by a light in the night time, such as *Polystoechotes nebulosus* and the Caddis flies (Fig. 46, *Neuronia semifasciata*); and a bright light placed in damp situations by streams, etc., will attract large numbers, the smaller species, like moths, being attracted a great distance by light. Other species of this group, so numerous in the northern states, are found in great numbers floating on lakes and ponds. For the proper study of the genera of these insects, and often of the species, they should be collected in alcohol, so as to be studied in a flexible state.

Fig. 46.



Caddis Fly and Larva and its Case.

Fig. 47.

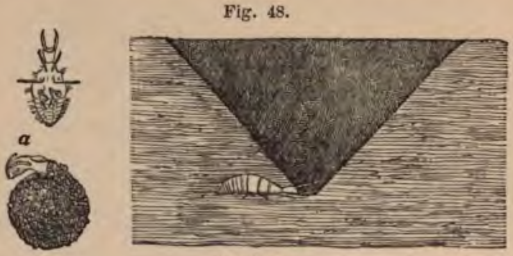


Ant-lion, adult.

The aquatic larvæ and pupæ can be reared in aquaria in jars and tumblers, taking care that the weaker species are separated from those more powerful and bloodthirsty. The little Entomostraca, or water fleas serve as food for the smaller species. With care many species can be reared in this way, and so little is known of their transformations that figures and descriptions would be of great value. The interesting and varied habits of the different families can also easily be noted.

The Ant-lions (Fig. 47) in the larva state (Fig. 48) dig pitfalls in the sand. The adults may be preserved in the same manner as Dragon flies.

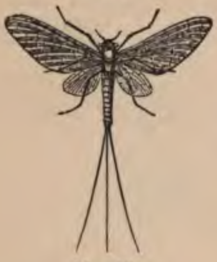
Fig. 48.



Ant-lion.

The May flies, or Ephemerids (Fig. 49), as their name implies, are, when fully grown, very short-lived insects, the adult living but a few hours. The body is slender and weak, being very long; the prothorax is of moderate size; the antennæ are subulate, awl-like, being very small, as in the dragon flies, while the parts of the mouth are rudimentary, the insect taking no food in the adult or imago state. The wings are very unequal in size, the hinder pair being much smaller, or in some instances (*Chloë* and *Cœnis*) entirely aborted; the transverse veins are either few or numerous; the tarsi are four or five jointed, and appended to the long, slender abdomen are two or three long caudal filaments.

Fig. 49.

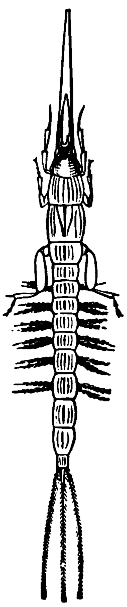


May Fly.

The sexes unite while on the upper surface of the water, and after a short union the female drops in the water her eggs "in two long, cylindrical yellow masses, each consisting of numerous minute eggs." Walsh states that he possesses a "subimago of *Palingenia bilineata*, which oviposited in that state."

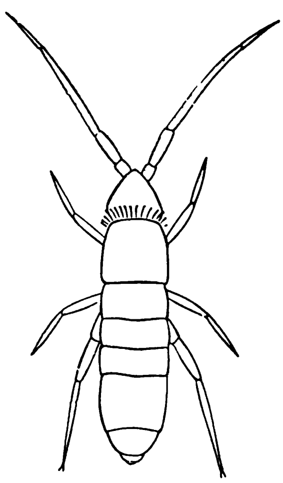
The larvæ live in running water and prey on small aquatic insects, the body being long and flat, with long hair-like antennæ, and small eyes situated on the side of the head, the ocelli not usually being present, and long sickle-shaped jaws, while along each side of the abdomen are leaf-like or bushy false gills, and the body ends in long feathered anal hairs. They live, it is stated, two or three years, and reside in burrows in the mud, under stones, or among grass and weeds, where they may be taken with the water-net in great abundance, and are beautiful objects for the aquarium. Lubbock states that *Chloëon* passes through twenty-one moultings of the skin before it assumes the imago state; the pupæ are active and have, as a general rule, the rudiments of wings. After leaving the pupa skin the insect (sub-imago), when its wings are expanded, takes a short flight, and then casts another skin before reaching the final imago state. They often fly in immense numbers, and become stranded in winrows along the borders of lakes. The perfect insects should be preserved in alcohol for study, as they shrivel up when pinned. They should be described when alive if possible.

Fig. 50.



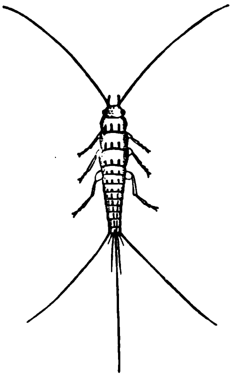
Ephemera larva.

Fig. 52.



Podura (*Tomocerus*).

Fig. 51.



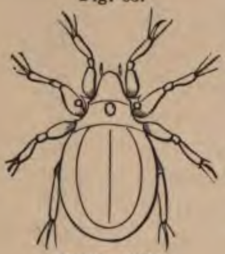
Lepisma 4-seriata.

The *Thysanura*, comprising the Lepisma (Fig. 51, *Lepisma 4-seriata* or Bristle Tail, and Podura or Spring Tail; Fig. 52, *Tomocerus plumbeus*) are found abundantly in damp apartments, or in moist dark places under sticks, stones, among fallen leaves, or under bark of trees, while some occur in great profusion about manure heaps and hot-beds in early spring. They should be collected in a mixture of alcohol and glycerine, equal parts, or alcohol alone. Collections from the western and Pacific states are very desirable.

ARACHNIDA.

SPIDERS, SCORPIONS AND MITES.

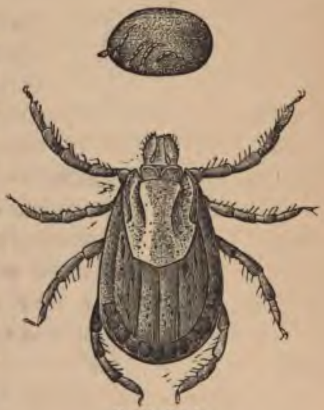
Fig. 53.



Nothrus Mite.

In studying spiders, of which there are in New England alone, according to Mr. Emerton, over two hundred species, the number and relative situation of the eyes, and the relative length of the different pairs of legs, should be noticed. Their webs and the manner of constructing them; their habitats, whether spreading their webs upon or in the ground, or in trees, or on herbage; or whether the species is aquatic, or erratic, and pursue their prey without building webs to entrap them, should be observed. So, also, how they deposit their eggs, and the form and appearance of the silken nidus, and whether the female bears her eggs about her, and how this is done, whether holding on to the egg-sac by her fore or hind legs, should all be carefully noticed. Care must be taken not to mistake the young or full-grown, mature species, and describe them as such. Spiders can be reared in boxes as insects. The only way to preserve them is to throw them into alcohol; when pinned, they shrivel up and lose their colors, which keep well in spirits.

Fig. 54.



Cattle Tick.

The colors of spiders vary much at different seasons of the year, especially during the frosts of autumn, when the changes produced are greatest. All spiders are directly beneficial to agriculture by their carnivorous habits, as they all prey upon insects, and do no harm to vegetation. Their instincts are wonderful, and their habits and organization worthy of more study than has yet been paid them. We have no species poisonous to man, except when the state of health renders the constitution open to receive injury from their bite, just as mosquitoes and black flies often cause serious harm to some persons.

The mites (Fig. 53, *Nothrus*) occur under bark, sticks, stones, or on the bodies of birds and mammals or insects. They should be preserved in alcohol.

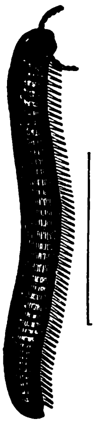
All kinds of Ticks (*Ixodes*, Fig. 54) should also be preserved in spirits, as well as the minute species of mites which occur everywhere.

MYRIOPODA.

CENTIPEDS, THOUSAND LEGS, MILLEPEDS.

The centipeds and millepeds (Fig. 55, *Julus multistriatus*) live in damp situations under stones, sticks, leaves, etc. They should be preserved in different stages of growth in spirits. Several species (*Spirostrephon*) live in caves and should be especially sought for.

Fig. 55.



Julus.

In conclusion we may say that while the Coleoptera, Lepidoptera, and Hymenoptera of the northeastern states of the union are comparatively well known, specimens of all orders from the southern and western states, the Pacific states, and the great plains, *however common*, are eagerly desired, as well as all cave insects. Specimens received by the Smithsonian Institution will be forwarded to experts for identification and description. Specimens should always be accompanied by small paper labels attached to the pin or placed in the bottles. If written in pencil on heavy paper the marks will endure for a long time. Always state the locality and date of capture.

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